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METHOD AND INSTALLATION FOR THE PRODUCTION OF LIME  
WATER FROM DEIONISED WATER

The invention relates to the domain of water treatment.

More precisely, the invention relates to the domain of production of lime water for use in  
5 remineralising water with low mineral content and more precisely water that has been subjected to a deionisation step either by membrane filtration (of the reverse osmosis, nanofiltration type), or by distillation, or by passage on an ion exchange resin.

10 This water may be slightly or not at all mineralised, and has the disadvantage of being corrosive and therefore inducing degradation to installations used for transport or treatment of the water.

15 Furthermore, this water has a high equilibrium pH value, in the sense of calcocarbonic equilibrium of the water. This high value is incompatible with good efficiency of some disinfectants such as chlorine. Therefore, the water should be remineralised in order  
20 to reduce the equilibrium pH value.

In the remineralisation method, it is known that a base, and particularly limewater, can be added to the water.

5 Special devices called "saturators" have to be used due to the low solubility of lime in water, so as to obtain a limewater with constant titre enabling precise dosage.

Ideally, the objective is thus to produce quality lime water using such saturators, with a titer in  
10 practice of about 220°F TAC (total alkali strength) at a temperature of 20°C, namely 1.65 g/litre of  $\text{Ca}(\text{OH})_2$  with a turbidity less than 10 NTU. Due to its clarity, this type of limewater in the form of a saturated solution may be mixed with water to be treated to  
15 efficiently remineralise it using gaseous  $\text{CO}_2$ .

Conventionally, saturators receive firstly a quantity of lime in the form of milk of lime (of the order of 20 to 100g/litre) injected into the saturator base or into a mixing chamber internal to or external  
20 to the saturator, and secondly dilution water (water to be saturated by lime). Additional water, called "spraying water", is used to adjust the production rate and improve the mixing quality. Lime is brought in liquid form as milk of lime and is dissolved as it  
25 rises into the saturator, generating a fraction of calcium carbonates and other insoluble particles which can be continuously or discontinuously purged.

Conventionally, the dilution water used to dilute the milk of lime in the saturator is mineralised water  
30 or water that has been subjected to a remineralisation treatment. In the rest of this description, we will

call this water "non-deionised water", and it has simply been subjected to a so-called "non-deionising" filtration either by granular filtration on sand, or sometimes by micro-filtration or ultra-filtration, which has the disadvantage that it does not retain dissolved or undesirable molecules such as pesticides or nitrates. When included in the limewater designed to remineralise the deionised water, this water contributes to polluting it to a certain extent, admittedly not in large quantities but nevertheless undesirable. It is then possible to eliminate pesticides and / or nitrates from this water by a combination of means such as active carbon and biological denitration or denitration on resins, but the easiest way is often to use deionised water produced by the plant directly.

However, it has been observed that the use of deionised water that has either been thoroughly membrane filtered, or distilled, or water that has been subjected to a treatment with ion exchanging resins to produce lime water, instead of water on which only a non-deionising filtration has been carried out, led to the production of a lime water that quickly became cloudy due to precipitation of carbonates originating from atmospheric or dissolved  $\text{CO}_2$ . The turbidity of this type of limewater produced in this way from water that is very little or not at all mineralised can conventionally be between 50 and 100NTU. This type of turbidity prevents its use during the remineralisation step of water on which a thorough membrane filtration has been carried out.

One purpose of this invention is to propose a new method for production of limewater from deionised water leading to a limewater from which all undesirable pesticide or nitrate type molecules have been removed, and in general from which all molecules not eliminated by non-deionising filtration have been removed.

Another purpose of this invention is to have lime saturators with efficiency greater than lime saturators supplied with filtered water. Saturator yields are conventionally between 75 and 95%, in other words the lime loss can be as high as 25%.

Another purpose of this invention is to present such a method to obtain limewater with a turbidity less than 10NTU for a saturator efficiency greater than 95%.

Yet another purpose of this invention is to describe such a method that can be used in a lime saturator that is only slightly different from the lime saturator according to prior art.

These different objectives are achieved by the invention that relates to a method for production of lime water comprising a step in which milk of lime is mixed with dilution water, characterised in that the said dilution water is water deionised by membrane filtration or by distillation or by passage on an ion exchanger resin, and in that it includes a preliminary step consisting of adding silicate ions to the said deionised water.

Surprisingly, it has been observed that the use of silicate ions provides a means of obtaining a limewater with low turbidity and good saturation efficiency. Moreover, use in this way as dilution water for water

that has been deionised, considerably reduces the probability of finding undesirable molecules in the water remineralised using limewater obtained using this method.

5       The use of such a compound can improve flocculation and precipitation, resulting in improved surface velocities greater than 2 m/h.

It should be noted that in the context of the method according to the invention, a silicate is used  
10 in preference chosen from the group composed of sodium silicate and potassium silicate, and that in preference, sodium silicate which has a lower treatment cost will be used.

As indicated above, the dilution water used in the  
15 context of the method according to the invention is not water that has been subjected to a coarse non-deionising filtration, but is water on which a thorough membranes filtration has been carried out or which has been distilled. This thorough membranes filtration may  
20 be a nano-filtration or a filtration by reverse osmosis.

Different means could be envisaged to add silicate ions to the deionised water. According to one variant, this addition step will be used mixing this compound.  
25 According to another variant, silicate will be introduced into the said saturator.

Furthermore, it should also be noted that silicate will be added to dilution water or into the saturator, preferably at a content of 5 mg/l to 40 mg/l, and  
30 preferably 10 to 20mg/l, of SiO<sub>2</sub> with respect to the dilution water.

This invention is also intended to cover any installation for the production of limewater using the method described above comprising an installation for the production of lime water using the method described  
5 above, the said installation comprising:

- at least one lime saturator,
- means of bringing the dilution water into the said lime saturator,
- means of bringing milk of lime into the said  
10 lime saturator,
- means of evacuating the limewater obtained by bringing the milk of lime into contact with the dilution water,
- means of evacuating unburnt materials and /  
15 or precipitates,

characterised in that it includes conveyance means for bringing silicate ions into the dilution water or into the saturator using a specific pipe.

Therefore the installation according to this  
20 invention is distinguished from classical installations in that it includes additional means of bringing silicate ions into the deionised dilution water.

Preferably, this installation also includes means of mixing silicate ions in the dilution water which, in  
25 the method according to the invention, is composed of ionised water on which a thorough membrane filtration has been carried out, or distillation, or treatment by passage on an ion exchanger resin.

Preferably, these mixing means capable of diluting  
30 silicate ions in dilution water include at least one

mixing system which may be a static mixer or a mixing tank.

Finally, it should be noted that according to one variant of the invention, the installation also includes means of measuring the quality of limewater produced in the saturator and means of varying the silicate dose brought in by the conveyance means in the dilution water. Such measurement means may for example include a turbidimeter and / or a pH meter and / or conductivity measurement means.

This type of means can be used to add the silicate in just the right quantity to obtain the required quality of limewater produced using the installation.

The method and the installation according to this invention can be used to obtain lime water with turbidity less than 10 NTU with a saturation efficiency equal to at least 95%, that can be perfectly suitable for remineralising water on which a membrane filtration, or distillation, or resin treatment method has been carried out.

The invention also relates to any use of limewater obtained using the method described above in the context of a method to remineralise water to be remineralised by the addition of limewater and carbon dioxide.

The invention and its various advantages will be better understood after reading the following description of a non-limitative embodiment of the invention with reference to Figure 1 that shows a diagrammatic view of an installation for the treatment

of water on which a membrane filtration method has been carried out.

In Figure 1, the installation comprises a lime saturator 1, means 2 of conveying the milk of lime into the said lime saturator 1, means 3 of conveying dilution water into the lime saturator, means 4 of eliminating the lime water obtained by bringing the milk of lime into contact with the dilution water in the lime saturator 1. It should be noted that conventionally, the lime saturator 1 also comprises a spraying water inlet 12 injecting water to facilitate mixing between the milk of lime and the dilution water. This lime saturator is also provided with a carbonates and insolubles trap 13 to evacuate carbonates formed in the lime saturator, and means 14 of evacuating sludge formed in the lower part of the saturator including an evacuation pipe 15 and a pump 16.

According to this invention, dilution water is composed of water that has been thoroughly membrane filtered, in this case nano-filtered water pumped by a pump 5 in a nano-filtered water reservoir 6.

Also according to this invention, the installation includes means 7 of bringing silicate ions into the dilution water. These means include a silicate reservoir 8, a pump 9 and a pipe 10.

Also according to this invention, the silicate ions are mixed with dilution water, for example using a static mixer 11, before this mix is added into the lime saturator 1. In the context of this embodiment, a static mixer 11 is used.



Also according to this invention, a turbidimeter 17 is provided on means 4 intended for evacuating limewater formed in the lime saturator 1, and means 18 of varying the silicate dose brought by means 7 for conveying this compound in the dilution water, are also provided.

This installation was tested using potassium silicate and sodium silicate. The concentration of silica, and the density and consistence of these reagents are shown in Table 1 below.

Silicate	Concentration of SiO <sub>2</sub>	Density
sodium	25	1.36
potassium	22.6	1.29

Table 1

The total alkali strength (TAC) of lime water produced according to the invention was measured and compared with the TAC of lime water obtained conventionally, using water that has been subjected to a non-deionising filtration such as granular filtration on sand for production of lime water, rather than dilution water composed of water on which a membrane filtration has been carried out.

The coverage ratio of the TAC of limewater produced according to this invention, is measured and compared with the TAC of limewater obtained according to the state of the art. The turbidity at equilibrium of limewater obtained was also measured.

For potassium silicate, limewater production tests with additions of 0, 5, 6 and 20 mg/l of  $\text{SiO}_2$  were carried out.

For sodium silicate, limewater production tests with additions of 0, 3, 9 and 32 mg/l of  $\text{SiO}_2$  were carried out.

Tables 2 and 3 below show the results obtained for potassium silicate and sodium silicate respectively, with deionised dilution water.

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Potassium silicate content (in ppm of $\text{SiO}_2$ )	Turbidity at equilibrium (NTU)	TAC coverage ratio compared with TAC obtained according to prior art (in %)
0	>50	/
5	9	95-100
6	7	95 to 100
20	5	95 to 100

Table 2

Sodium silicate content (in ppm of $\text{SiO}_2$ )	Turbidity at equilibrium (NTU)	TAC coverage ratio in comparison with TAC obtained according to prior art (in %)
0	>50	/
3	12	95-100
9	7	95 to 100
32	5	95 to 100

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Table 3

The addition of silicate according to this invention systematically causes precipitation of  $\text{CaH}_2\text{SiO}_4$ . Precipitates of this compound, in the form of  
5 1 to 3 mm diameter flocs, settle at the bottom of the saturator, making the limewater clear. The quantity of flocs increases as the silicate content increases. This type of flocculation forms a complete substitute for cloudiness that can be caused by calcium carbonates  
10 when no silicate compound is added, in other words when membrane filtered water or distilled water is used for the production of limewater. The limewater between the flocs is perfectly clear when reagents according to the invention are added. When these compounds are not  
15 added, the limewater becomes cloudy and milky and its turbidity increases to about 50 NTU.

TAC measurements on the lime water produced from water on which a nano-filtration has been carried out gave results systematically between 210°F and 230°F,  
20 and were always of the same order as results obtained on lime water produced according to the state of the art, from water filtered on sand. The calculated coverage ratio was thus always between 95% and 100%.

It should be noted that the embodiment of the  
25 invention described herein is not intended to reduce the scope of the invention.